PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2000-348739

(43)Date of publication of application : 15.12.2000

(51)Int.Cl. H01M 8/02
C08K 3/00
C08L101/00

(21)Application number : 11-157475

(22)Date of filing : 04.06.1999

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(54) RESIN COMPOSITION FOR FUEL CELL SEPARATOR

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a resin composition for a fuel cell separator having high conductivity and tenacity, and capable of being produced with high productivity.

SOLUTION: This composition is formed of a mixture of (a) a low-melting point metal, (b) metal powder, (c) a thermoplastics and (d) a thermoplastic elastomer; and in the composition, the ratio of the metal constituent comprising (a) and (b) to the entire composition is in the range of 20-70 vol.%, the ratio of the constituent (b) to the metal constituent is in the range of 10-30 vol.%, and the ratio of the constituent (d) to the resin constituent comprising the constituents (c) and (d) is in the range of 10-100 vol.%.

LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's

decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the resin constituent for separators of the fuel cell cel which has a gas passageway for gas supply in said electrode side at least while it contacts one pair of electrodes which put an electrolyte membrane and is used for current collection from an electrode.
[0002]
[Description of the Prior Art] Advanced conductivity is required for the separator (only henceforth a separator) of the above-mentioned fuel cell cel for the sake of the convenience which carries out current collection from an electrode. Furthermore, gas impermeability, corrosion resistance, a mechanical strength, etc. are needed. And although the gas passageway and cooling slot for supplying gas to an electrode were formed in the separator, conventionally, the formation approach performed cutting, such as an end mill and a milling cutter, to an electrical conducting material like a metal plate or a carbon plate, and was formed in it.
[0003]
[Problem(s) to be Solved by the Invention] although the example constitute from metallic materials , such as a pure copper and stainless steel , as a separator ingredient be know , in order to contact [the hydrogen gas and the long duration which it become heavy in weight , and also be use as fuel gas] , since the fault from which a hydrogen embrittlement arise and quality of the material degradation arise , cutting in slot formation , etching processing , etc. be need , with the quality of the material of these metal systems , the increase of cost accompanying the increment in a man day and it be avoid . Moreover, although there is an example which adopts the substantia-compacta carbon plate other than a metal system, forms a gas passageway in this plate through cutting, and is made into the separator, and lightweight-ization can be attained, manufacture of the plate itself takes long duration and there is a problem that productivity is bad. Since slice cutting by the diamond cutter for considering as a plate with processing of passage as well as [still] use of a metal plate was needed, the increase of cost accompanying the increment in a man day and it was not avoided.
[0004] This invention aims at offering the separator which was rich in productivity while it is equipped with the advanced conductivity which was extremely excellent in current collection nature that the trouble of the conventional separator should be solved.
[0005]
[Means for Solving the Problem] The place which this invention finds out the constituent for separators of the fuel cell cel which can cancel an above-mentioned trouble, and is made into the summary While contacting one pair of electrodes which put an electrolyte membrane and being used for current collection from an electrode It is the separator for fuel cells which has a gas passageway for gas supply in said electrode side, and has a cooling water way in an anti-electrode side. (a) It consists of mixture of a low-melt point point metal, (b) metal powder, (c) thermoplastics, and (d) thermoplastic elastomer, and is in the separator of the fuel cell cel characterized by the above-mentioned component containing in the specific range.

[0006]
[Embodiment of the Invention] Hereafter, this invention is explained in detail. Drawing 1 is the cross-section schematic diagram having shown the structure of the fuel cell cel of a solid-state macromolecule mold. As shown in this drawing 1 , the fuel cell cel 10 is equipped with the separator 20 which contacts at an electrode an electrolyte membrane 12 and the electrode 11 of the pair made into sandwich structure on both sides of this electrolyte membrane 12 from both sides, inserting this sandwich structure from both sides. A separator 20 has the gas passageway 21 for gas supply in an electrode side, and has the cooling water way 22 in the opposite side of an electrode. This cooling water way 22 can be formed if needed. The range of the total thickness of a separator 20 is usually 1.0mm - 3.0mm.
[0007] The description is with the separator of the fuel cell cel of this invention for the ingredient of the separator to consist of mixture (henceforth an "admixture") of (a) low-melt point point metal, (b) metal powder, (c) thermoplastics, and (d) thermoplastic elastomer. It is required 20 - 70 capacity [of the whole constituent] % and to contain preferably the metal component which set (a) low-melt point point metal and (b) metal powder in the admixture in the range of 45 - 65 capacity %, and they need to make the rate of the (b) component in a metal component the range of 10 - 30 capacity %. A metal component cannot discover conductivity easily under by 20 capacity %, and when 70 capacity % is exceeded, there is a problem that a fluidity falls and it is inferior to a moldability. Moreover, the metal powder of (b) becomes easy to stiffen as if it acts as a distributed assistant of a low-melt point point metal, and a distributed condition worsens [the rate of (b) in a metal component] below by 10 capacity % and a fluidity falls above 30 capacity %, and has the problem that conductivity also falls further.
[0008] Although various kinds of things can be used for the low-melt point point metal of the above-mentioned (a) component, the melting point is a metal 300 degrees C or less, and the solder which consists of the Pb/Sn, Pb/Sn/Bi, Pb/Sn/Ag, Pb/Ag, Sn/Ag, Sn/Bi, Sn/Cu, and Sn/Zn system can usually use it suitably. (b) The metal powder of a component serves as a distributed assistant of the above-mentioned low-melt point point metal, Cu, nickel, aluminum, Cr(s), and those alloy powder can use it suitably, and its range the mean particle diameter of whose is 1-50 micrometers is desirable. Mean particle diameter is number average particle diameter for which photoed the sample with the transmission electron microscope and it asked from the photograph. The handling in the case of mixing of mean particle diameter in less than 1 micrometer is difficult, and dispersibility tends to fall in the thing exceeding 50 micrometers.
[0009] Polyolefine system resin, such as polypropylene (PP), ABS plastics, PC resin, denaturation PPO resin, polyacetal resin, PPS resin, and liquid crystal polymer resin can use it suitably from thermal resistance, a water resisting property, and a chemical-resistant viewpoint that what is necessary is just what can bear the bottom of the environment where a separator is used, as thermoplastics of the (c) component used for an admixture. (d) Kneading nature with the thermoplastics of the (c) component with which the thermoplastic elastomer of a component is used should be just good, and an olefin system elastomer, a styrene system elastomer, a vinyl chloride system elastomer, an urethane system elastomer, an ester system elastomer, and an amide system elastomer are used suitably. For example, when the thermoplastics of the above-mentioned (c) component is PP, the olefin system elastomer which is excellent in kneading nature as thermoplastic elastomer of (d) is suitable. the rate in the resinous principle which the function of (d) in an admixture reduced the brittleness of the whole admixture, gives toughness, and doubled (c) and (d) -- 10 - 100 capacity % -- it is preferably mixed in the range of 10 - 30 capacity %. Under by 10 capacity %, if it is made the high concentration which does not contribute to reduction of the brittleness of admixture and exceeds 100 capacity %, admixture will become soft too much and configuration maintenance will become difficult as a separator.
[0010] Moreover, the resin below 55 (it measures based on JIS K7215) is suitable, durometer D hardness is too hard by the degree of hardness beyond it, and, as for the degree of hardness of the thermoplastic elastomer of the (d) component used, it is hard to achieve the function of the above-mentioned brittle improvement. The above-mentioned admixture has a desirable approach using that which corned after kneading what carried out physical mixing of each powder with kneading machines, such as a kneader and a biaxial extruder, at predetermined temperature. The temperature from which the

low-melt point point metal of the (a) component will be in a half-melting condition in kneading is desirable, and it is necessary to choose a suitable metal presentation according to the melting temperature of the resinous principle used as a matrix, and to choose suitably the addition ratio of metal powder, such as copper powder and nickel powder, used as a low-melt point point metal and a distributed assistant.

[0011] Size enlargement is possible for the granulation object of the admixture obtained by the above-mentioned approach by performing injection molding, transfer molding, press forming, etc. using the metal mold which has a separator configuration. Considering productivity, injection molding is effective. Although they achieve the function as a separator also as [this], considering the endurance by the side of an electrode, as for the obtained mold goods, it is desirable to perform metal plating and spatters, such as gold and silver, to a front face. The electric corrosion of the metal component in a separator can be prevented by plating of these metals or the spatter.

[0012] As explained above, it can also hold a certain amount of toughness while it shows high conductivity, since a low-melt point point metal and thermoplastic elastomer contain the separator of the fuel cell cel of this invention in thermoplastics. moreover, the same **** for the shaping approaches as usual thermoplastics -- since things are made, in considering as the configuration which has passage, cutting is not needed. Therefore, the separator of the fuel cell cel of this invention turns into a separator which was equipped with high conductivity required as a separator, and toughness, and was rich in productivity.

[0013]

[Example] Hereafter, although an example is explained, this invention is not limited to this.

(Example 1) Pb/Sn system solder (Pb70%, Sn30%) was used as a low-melt point point metal, copper powder with a mean particle diameter of 10 micrometers was used as metal powder, PP resin ("PN640" Tokuyama make) was used as thermoplastics, and Santoprene (made in "121-50M" AES Japan) was used as thermoplastic elastomer. Physical mixing of each raw material powder was carried out beforehand (low-melt point point metal 45 capacity %, metal powder 5 capacity %, thermoplastics 25 capacity %, thermoplastic-elastomer 25 capacity %), using the biaxial extruder (Product made from a "2D25-S" Oriental energy machine), after melting kneading, it pelletized and the solder content resin pellet was created. The extrusion conditions are as follows.

[0014]

Cylinder temperature: 220-degree-C screw speed: 20r.p.m.

Then, injection molding of the solder content resin pellet created above was carried out to the die for injection molding which the female mold and the male were made to counter on condition that the following.

Die temperature : 40-degree-C cylinder temperature : 220-degree-C screw speed : 50r.p.m.

Injection rate : 60cm3/sec injection pressure : 80MPa back pressure : 2MPa dwelling (cooling) time amount : After 40sec cooling, it unmolded and the target separator was obtained.

[0015] The property of this separator was as follows.

Volume-resistivity value: 4.5x10-4 ohm-cm gas permeability : 10 to 6 or less (opposite gaseous helium) cc/atm/sec

amount [at the time of bending test fracture] of deflections (brittle index): 2.5mm (JIS K7111 -- conformity: -- test piece width of face [ ] -- 10mm and distance [ ] between the supporting points -- 20mm and test period 0.5 mm/min)

[0016] (Example 1 of a comparison) All others evaluated by these conditions by using all the resinous principles of an example 1 as thermoplastics (with no thermoplastic elastomer). The property of this separator was as follows.

Volume-resistivity value: 5.2x10-4 ohm-cm gas permeability : 10 to 6 or less (opposite gaseous helium) cc/atm/sec

amount [at the time of bending test fracture] of deflections (brittle index): 0.61mm (JIS K7111 -- conformity: -- test piece width of face [ ] -- 10mm and distance [ ] between the supporting points -- 20mm and test period 0.5 mm/min)

[0017] (Example 2) Lead-free soldering (Sn-4Cu-2nickel) was used as a low-melt point point metal, copper powder with a mean particle diameter of 10 micrometers was used as metal powder, PP ("PN640" Tokuyama make) resin was used as thermoplastics, and Santoprene (made in "121-50M" AES Japan) was used as thermoplastic elastomer. Physical mixing of each raw material powder was carried out beforehand (low-melt point point metal 45 capacity %, metal powder 5 capacity %, thermoplastics 25 capacity %, thermoplastic-elastomer 25 capacity %), using the biaxial extruder (Product made from a "2D25-S" Oriental energy machine), after melting kneading, it pelletized and the solder content resin pellet was created. The extrusion conditions are as follows.
[0018]
Cylinder temperature: 220-degree-C screw speed: 20r.p.m.
Then, injection molding of the solder content resin pellet created above was carried out to the die for injection molding which the female mold and the male were made to counter on condition that the following.
Die temperature : 40-degree-C cylinder temperature : 220-degree-C screw speed : 50r.p.m.
Injection rate : 60cm3/sec injection pressure : 80MPa back pressure : 2MPa dwelling (cooling) time amount : After 40sec cooling, it unmolded and the target separator was obtained.
[0019] The property of this separator was as follows.
Volume-resistivity value: 8.2x10-4 ohm-cm gas permeability : 10 to 6 or less (opposite gaseous helium) cc/atm/sec
amount [at the time of bending test fracture] of deflections (brittle index): 2.8mm (JIS K7111 -- conformity: -- test piece width of face [ ] -- 10mm and distance [ ] between the supporting points -- 20mm and test period 0.5 mm/min)
[0020] (Example 2 of a comparison) All others evaluated by these conditions by using all the resinous principles of an example 2 as thermoplastics (with no thermoplastic elastomer). The property of this separator was as follows.
Volume-resistivity value: 6.7x10-4 ohm-cm gas permeability : 10 to 6 or less (opposite gaseous helium) cc/atm/sec
amount [at the time of bending test fracture] of deflections (brittle index): 0.68mm (JIS K7111 -- conformity: -- test piece width of face [ ] -- 10mm and distance [ ] between the supporting points -- 20mm and test period 0.5 mm/min)
[0021]
[Effect of the Invention] As mentioned above, since the low-melt point point metal contains the separator for fuel cells of this invention to resin, it shows high conductivity. moreover, the same **** for the shaping approaches as usual thermoplastics -- since things are made, in considering as the configuration which has passage, cutting is not needed. Since the elastomer is furthermore used as a resinous principle, brittleness can be controlled. Consequently, the separator of the fuel cell cel of this invention is equipped with high conductivity required as a separator, and toughness, and has the advantage of excelling in productivity.

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CLAIMS

[Claim(s)]
[Claim 1] (a) A low-melt point point metal, (b) metal powder, (c) thermoplastics, The metal component which consisted of mixture of (d) thermoplastic elastomer and doubled (a) and (b) And 20 - 70 capacity [of the whole constituent] %, Moreover, the resin constituent for separators of the fuel cell cel characterized by the rate of (d) in the resinous principle with which the rate of the (b) component in a metal component doubled 10 - 30 capacity %, (c), and (d) being the range of 10 - 100 capacity %.
[Claim 2] (a) The resin constituent for separators of the fuel cell cel according to claim 1 characterized by the low-melt point point metal of a component consisting of a solder chosen from the Pb/Sn, Pb/Sn/Bi, Pb/Sn/Ag, Pb/Ag, Sn/Ag, Sn/Bi, Sn/Cu, and Sn/Zn system.
[Claim 3] (b) The resin constituent for separators of the fuel cell cel according to claim 1 to 2 characterized by being the range the mean particle diameter of whose is 1-50 micrometers by the metal powder of a component consisting of Cu, nickel, aluminum, Cr(s), and those alloy powder.
[Claim 4] (c) The resin constituent for separators of the fuel cell cel according to claim 1 to 3 characterized by coming to choose the thermoplastics of a component out of polyolefine system resin, ABS plastics, PC resin, denaturation PPO resin, polyacetal resin, PPS resin, and liquid crystal polymer resin.
[Claim 5] (d) The resin constituent for separators of the fuel cell cel according to claim 1 to 4 characterized by coming to choose the thermoplastic elastomer of a component out of an olefin system elastomer, a styrene system elastomer, a vinyl chloride system elastomer, an urethane system elastomer, an ester system elastomer, and an amide system elastomer.

[Translation done.]